

REMARKS

Rejections Under 35 USC §112, second paragraph

Claims 5, 21, 25 and 29 have been rejected under 35 USC §112, second paragraph, because the term "bisaleimide-trizine (BT)" has no plain meaning. In response to these rejections, claims 5, 21, 25 and 29 have been amended to replace the term "bisaleimide-trizine (BT)" with the term "organic polymer material". Antecedent basis for "organic polymer material" is contained on page 10, lines 10-12 of the specification.

Rejections Under 35 USC §102 and 35 USC §103

Claims 1-4, 6-12, 14-20, 22-24, 26-28 and 58-64 have been rejected under 35 USC §102(e) as being anticipated by Glenn (US Patent No. 6,586,826).

Claims 5, 13, 21, 25 and 29 have been rejected under 35 USC §103(a) as being unpatentable over Glenn as applied to claims 1, 9, 18, 22 and 26, and further in combination with applicant's admitted prior art.

Claims 1, 3, 4-8, 13, 18-29 and 58-61 have been rejected under 35 USC §103(a) as being unpatentable over Akram (US Patent No. 6,122,171) and applicant's admitted prior art.

Summary of the Invention

Claims 1-29 are directed to a semiconductor package (50-Figure 2A, 50A-Figure 5, 50B-Figure 6 or 50C-Figure 7). Claims 58-64 are directed to an assembly (130-Figure 8A) that includes the package (50, 50A, 50B or 50C).

As shown in Figure 2A, a first embodiment package 50 includes a substrate 54, a semiconductor die 52 mounted to the substrate 54, and an encapsulant 48 molded to the substrate 54 encapsulating the die 52. The substrate 54 comprises a conventional "board" material such as an

organic polymer resin reinforced with glass fibers. In addition, the substrate 54 includes die contacts 86 that are placed in electrical communication with bond pads 60 on the die 52 using a process such as thermocompression bonding, wire bonding or TAB bonding. The substrate 54 also includes conductors 72 (Figure 2B) and bonding sites 66 in electrical communication with the die contacts 86.

As shown in Figure 2A, the package 50 also includes external contacts 84 on the bonding sites 66 arranged in a dense grid array, and configured as input/output ports for the package 50. The external contacts 84 comprise multi layered metal bumps that include a base layer 88 (first layer) on the bonding sites 66, a bump layer 90 (second layer) on the base layer 88, and an outer layer 92 (third layer) on the bump layer 90. The base layer 88 comprises a metal such as copper, that adheres to the bonding sites 66, which can also comprise copper. The bump layer 90 comprises a metal such as nickel, that can be easily deposited to a desired thickness on the base layer 88. The outer layer 92 comprises a non-oxidizing metal, such as gold, that will bond easily to mating electrodes 136 (Figure 8B) on a supporting substrate 132 (Figure 8B).

As shown in Figure 5, a second embodiment package 50A, includes a stacked die 52A back bonded and wire bonded to the substrate 54A in a chip-on-board configuration.

As shown in Figure 6, a third embodiment package 50B, includes a die 52B, adhesively bonded and wire bonded to the substrate 54B in a board-on-chip configuration.

As shown in Figure 7, a fourth embodiment package 50C, includes a stacked die 52C back bonded and wire bonded to a recess 124C in the substrate 54C in contact with a heat spreader 120C.

Argument

The 35 USC §102 and 35 USC §103 rejections are traversed for the reasons to follow. However, the claims have been amended to include additional recitations which further distinguish the claimed invention from the prior art.

A first distinguishing feature recited in independent claims 1, 9, 14, 18, 22, 26, 58 and 62 is that the package includes external contacts (84-Figure 2A) in the form of "multi layered metal bumps". Antecedent basis for this recitation is contained on page 6, line 22, of the specification.

In Glenn et al. cited in the 35 USC §102 and 35 USC §103 rejections, the posts (18, 20-Figure 2) were cited as being equivalent to the presently claimed external contacts (84-Figure 2A). However, the posts (18, 20-Figure 2) are not multi layered metal bumps, but are molded plastic posts (column 3, lines 27-28) covered with metal layers (column 6, lines 58-60). The posts (18, 20-Figure 2) require a complicated interconnection scheme wherein first posts (20-Figure 3A) on an upper package (10-Figure 2) mate with a pattern of four second posts (18-Figure 3A) on a lower package (10-Figure 2). The present external contacts (84-Figure 2A) are multi layered bumps, which attach directly to an electrode (136-Figure 8B) on a substrate (132-Figure 8B) such as a PCB. The present external contacts (124, 126-Figure 2) are designed to take the place of conventional terminal contacts in the form of solder balls or bumps.

In addition to being simpler than the posts (18, 20-Figure 2) of Glenn et al., the present terminal contacts (84-Figure 2A) are easier to fabricate. In particular, the present external contacts (84-Figure 2A) can be manufactured using conventional semiconductor fabrication processes, such as deposition and etching. The posts (18, 20-Figure 2) in Glenn et al. require injection molding

equipment (column 3, lines 17-20) such as molds, that are expensive to make, and suited to only one layout.

In Akram et al. '171 cited in the 35 USC §103 rejections, the external contacts comprise conventional balls (124, 126-Figure 2) of a fine-pitch ball array (column 4, lines 26-28). These balls 124, 126 are made of solder (column 11, lines 37-38), and the heat sink (128-Figure 2) is also solder (column 5, lines 9-11). Applicant is unable to locate any teaching in Akram et al. '171 that the balls (124, 126-Figure 2) comprise multi layered metal bumps as with the presently claimed external contacts (84-Figure 2A). In Figures 19 and 20 of Akram et al. '171, the multi layers (154, 156, 158-Figures 19-20) are on the PCB (column 11, lines 27-40), rather than the balls 124, 126 being multi layered. The multi layers (154, 156, 158-Figures 19-20) in Akram et al. '171, are configured for bonding to the solder balls (124, 126-Figure 2). This is conventional external contact technology wherein the external contacts comprise solder and the PCB electrodes are configured to facilitate solder bonding. The presently claimed multi layered external contacts on the package, rather than the board, exhibit an insight running contrary to the conventional technology.

Another distinguishing feature of the present package is that the substrate (54-Figure 2A) includes both die contacts (86-Figure 2A) on a first side (circuit side 64-Figure 2A), and bonding sites (66-Figure 2A) on a second side (back side 62-Figure 2A). As shown in Figure 2A, the die contacts (86-Figure 2A) allow the die (52-Figure 2A) to be flip chip mounted to the substrate (54-Figure 2A). Alternately as shown in Figure 5, the die contacts (86A-Figure 5) allow the die (52A-Figure 5) to be wire bonded to the substrate (54A-Figure 5).

The Examiner has characterized the feature of the "die contacts" as being a "statement of intended use". Applicant disagrees with this view, as the die contacts are

an actual feature described with physical recitations. Amended independent claim 1 states that the bond pads on the die are "bonded to the die contacts". Amended independent claims 9, 14 and 62 state that both the external contacts and the die contacts comprise "multi layered bumps". No art has been cited against the feature of multi layered die contacts in combination with multi layered external contacts. Amended independent claim 18 states the bond pads on the die are "wire bonded to the die contacts".

The Examiner also maintains that the posts (18, 20-Figure 2) of Glenn et al. could inherently be used for die bonding. Applicant disagrees with this view as the posts (18, 20-Figure 2) are configured for interconnection to one another as shown in Figures 3A and 3B of Glenn et al. In order to bond a die to a substrate using such posts, the die would also need posts. Although this could be done, it is not an inherent characteristic of the posts.

Another distinguishing feature of the present package is that the multi layered external contacts (84-Figure 2A) are recited in combination with bonding sites (66-Figure 2A) on the substrate (54-Figure 2A). In amended independent claims 1, 14, 18, 22, 26, 58 and 62 the bonding sites are stated to comprise "an electrically conductive, bondable metal". Antecedent basis for this recitation is contained on page 11, lines 32-34 of the specification. In amended independent claims 9 and 14 the bonding sites are stated to be in an "array" (e.g., ball grid array). Antecedent basis for this recitation is contained on page 10, line 20 of the specification.

Admittedly bonding sites are known in the art. However, the present bonding sites are recited in combination with a substrate that includes multi layered terminal contacts and die contacts, which can also comprise multi layered metal bumps. In Glenn et al. the equivalent bonding sites are the plastic bases of the posts (18, 20-

Figure 2). These plastic bases are more expensive to make than the present bonding sites, which can be made using conventional processes such as deposition and etching.

As is well known by the Examiner, a proper 35 USC §102 rejection requires that each and every limitation of the claimed invention be disclosed in a single prior art reference. In addition, the reference must be enabling and describe the applicant's claimed invention sufficiently to have placed it in possession of a person of ordinary skill in the field of the invention. In re David C. Paulsen, 30 F.3d 1475, 31 USPQ 2d (BNA) 1671, (U.S. App 1994). In view of the above described distinguishing features, the amended claims are submitted to be novel over Glenn et al.

As is also well known by the Examiner, for a prima facie case of obviousness under 35 USC §103(a), MPEP 2142 requires that a combination of references must teach or suggest all the claim limitations. In the present case the combination of Glen et al. and the admitted art, and the combination of Akram et al. '171, do not teach multi layered metal external contacts on a substrate having die contacts which can also be multi layered metal bumps. In view of the above described distinguishing features, the amended claims are submitted to be unobvious over the cited combinations of references.

Conclusion

In view of the amendments and arguments, favorable consideration and allowance of claims 1-29 and 58-64 is requested. Should any issues remain, the Examiner is requested to contact the undersigned by telephone.

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